INTRODUCTION

OVERVIEW

The City of Brewer, Maine operates a municipal wastewater treatment facility which was constructed on Oak Street in 1975. The treatment plant provides service to about 9300 residents, numerous industrial, commercial, and institutional sewer users. About forty-six miles of collector sewers and fourteen wastewater pump stations convey sewage to the treatment plant. At the plant, pollutants are removed from the water. The goal of the treatment facility's operation is to convert the influent sewage into a clean effluent that can be discharged to the Penobscot River with no adverse environmental impacts. In addition, the effluent must achieve sufficient water quality standards to comply with the strict criteria specified in the City's federal and state wastewater discharge licenses.

The success of the treatment plant in producing a clean effluent is a function of how the facility is operated. The proper operation of the plant requires that staff take continuous measures to ensure that each unit process is operated at its maximum efficiency. This Operations and Maintenance Manual provides guidelines for the proper operation of the City's Water Pollution Control Facility.

RESPONSIBILITIES OF PLANT OPERATOR

The operators of the Brewer Water Pollution Control Facility play an important role in protecting the environment, maintaining the City's multi-million dollar investment in pollution control infrastructure, operating and optimizing the sewerage collection system, pump stations, and wastewater treatment plant, and complying with all federal and state license requirements. The operation of this facility is a professional position requiring a State of Maine Class V wastewater treatment plant operator's license. The large size of Brewer's facilities makes the system's operation complex. This makes it extremely important to staff the facility with operators that are knowledgeable in many pertinent areas including sewage collection systems, treatment plant operations and process control, sludge management and utilization, maintenance, laboratory testing, safety, record keeping, and public relations.

The operators of Brewer's wastewater treatment facilities must be able to successfully perform the following functions:

- Maintain the City's forty-six miles of gravity sewers and force mains that deliver raw sewage to the treatment plant.

- Operate and maintain the City's fourteen wastewater pumping stations that lift raw sewage over elevation changes along the sewer routes.

- Maintain and operate the many unit processes at the wastewater treatment plant.

- Conduct laboratory sampling and analysis to monitor the treatment plant's wastewater loadings, biological activity, and effluent quality.

- Make frequent process control adjustments in response to the laboratory results obtained at the plant.

- Observe and troubleshoot the facility's unit processes in a manner that allows proactive process control adjustments to be made in response to changing plant conditions.

- Maintain detailed records, logs, and reports that clearly document and outline all plant operations, maintenance, laboratory, and compliance activities.

- Conduct a proper safety program at the facility which allows all activities to be performed in a safe manner and without risk to the plant's staff or the public.

- Operate a sludge management program consisting of the proper thickening and wasting of excess sludge at the facility, reducing the volume of the sludge in a belt filter press system, and composting the dewatered sludge at Hawk Ridge Compost Facility in Unity, Maine.

- Assist the City in the annual preparation of a budget for wastewater treatment facilities.

- Conduct routine housekeeping functions to keep the plant presentable to the general public at all times.

- Keep the facilities properly painted, lubricated, and utilized in such a manner as to prolong their useful life.

- Communicate with the City’s Administrative Staff and City Council and keep them fully informed of operating conditions, performance, compliance, and issues at the plant or in the sewer system.

- Assist the City in enforcing all requirements of the City's sewer user ordinance.

The persons employed in the wastewater treatment plant operator positions must take annual training courses to stay abreast of changes in the profession and to comply with the state requirements for license renewal. The plant's operators should also be encouraged to network with other professional plant operators at nearby facilities and throughout the state in order to continually bring the most timely expertise to the Brewer facility. Additional position descriptions for treatment plant personnel can be found in Appendix A.

WASTEWATER COLLECTION SYSTEM

A schematic representation of the City of Brewer's sewer system is shown in Figure 1. About 2800 connected sewer users and a residential population of about 9300 people are served by the City's public sewer system. In addition, several large industries, a well established commercial and business base, and numerous institutional users utilize the City's wastewater collection and treatment infrastructure.

About 250,000 liner feet (LF) (47 miles) of public sewers and fourteen pumping stations, five of which are major stations along the interceptor sewer, convey raw sewage to the wastewater treatment plant on Oak Street. About 10% of the present sewer system is still combined and carries both sanitary wastewater and stormwater inflow in the same pipes. At one time, there were over 500 stormwater catchbasins connected to the sanitary sewer system. Today, only a few catchbasins remain connected and the City continues to remove additional basins as it proceeds with the implementation of its CSO Master Plan.

The sewer system is divided into ten major service districts which channel flow to five major pumping stations along the interceptor sewer route on the east shore of the Penobscot River. The Oak Grove and James Street sewer districts each have small pump stations that convey flows up to the Betton Street district and eventually to the Hardy Street pump station. The Hardy Street station, which is the City's largest, main pump station, also receives gravity flows from the Betton Street, Wilson Street, and Tannery Brook sewer districts. A second pump station at South Main Street collects flow from three sewer districts at Oak Street, Brewer Cove, and Brewer Street. The three larger pumps share a common force main that conveys wastewater flows to the treatment plant on Oak Street.

The sewer system contains many sections that are over 100 years old. Brick sewers are still in use in some of the older areas of the system. There are also many areas with vitrified clay pipe that are characterized by open, leaking joints. New sections of the sewer system, as well as areas that have been rehabilitated over the last decade, are constructed with watertight polyvinyl chloride (PVC) pipe.

Each of the City's ten major sewer districts used to discharge raw sewage to the Penobscot River in separate outfall pipes prior to the construction of the treatment plant in 1975. When the treatment facility was built, an interceptor sewer system was constructed along the river to intercept each of these outfall pipes; however, the old outfalls were left in place to provide a hydraulic relief

point should flows in the sewer system ever exceed the interceptor sewer's capacity. While CSO discharges are not acceptable today, it was common practice thirty years ago to incorporate them into the sewer system as a vital component of high flow management. In Brewer, a CSO point was established at the end of each of the ten sewer districts. This allowed peak flows to be relieved any time that peak stormwater inflow or peak groundwater infiltration reached volumes beyond those which the interceptor sewer system could carry. The City of Brewer has been systemically removing peak flows from its sewer system to reduce the number of CSO discharges and the frequency of their activation. At present, only one of the original ten CSO points remain active.

As shown in Table 1, there are fourteen pumping stations connected to the City's sewer system. The majority of the stations are small satellite facilities which bring flow from the outer reaches of the system towards the interceptor sewer and treatment plant. Seven of the stations fall under this category. The remaining five stations are located along the Penobscot River and interceptor sewer system and pump flows towards the treatment plant. Three of these stations at Hardy Street, South Main Street and Brewer Cove represent the endpoints of the interceptor sewer and are connected into the primary force main that feeds all of the City's wastewater flows into the treatment plant on Oak Street.

TABLE 1: BREWER'S WASTEWATER PUMPING STATIONS

LOCATION	TYPE	CAPACITY
Dirigo Drive	Smith & Loveless	100 GPM @ 19" TDH
Sparks Avenue	Smith & Loveless	120 GPM @ 27' TDH
Pierce Road	Smith & Loveless	600 GPM @123' TDH
Pine Ridge	Smith & Loveless	100 GPM @ 38' TDH
Cove Street	Meyers Submersible	100 GPM @ 30' TDH
Oak Grove Terrace	Smith & Loveless	150 GPM @ 57' TDH
Craig Drive	Smith & Loveless	130 GPM @ 85' TDH
Orrington Route 15	Gorman-Rupp	315 GPM @ 41' TDH
North Main Street	Smith & Loveless	180 GPM @ 24' TDH
Oak Grove	Smith & Loveless	600 GPM @ 166' TDH
James Street	Smith & Loveless	450 GPM @ 58' TDH
Hardy Street	Smith & Loveless	1900 GPM @ 58' TDH
South Main Street	Smith & Loveless	750 GPM @ 50' TDH
Brewer Cove	Smith & Loveless	725 GPM @ 66' TDH

OVERVIEW OF WASTEWATER TREATMENT FACILITY

All flows from Brewer's sewage collection system are conveyed to the City's wastewater treatment plant for processing. The objective of the treatment plant's operation is to convert incoming raw sewage into treated effluent of an acceptable water quality such that it may be discharged into the Penobscot River in compliance with the City's wastewater discharge licenses.

A process flow schematic diagram of the Brewer Water Pollution Control Facility is shown as Figure 2. The plant is designed to remove incoming pollutants from the raw sewage flow stream and to then convert the pollutants into sludge residuals for further processing.

- The pump stations at Hardy Street, South Main Street, and Brewer Cove convey all wastewater flows to the plant up to the interceptor sewer's hydraulic capacity. At each station, complete redundancy was designed to allow the peak flows to be pumped even if one pump is off-line for repairs.

- Raw sewage enters the Brewer treatment facility through a 20" Ø ductile iron force main interceptor sewer that collects wastewater from the Hardy Street, South Main Street, and Brewer Cove pump stations.

he municipal wastewater flows enter an aerated grit chamber that has two parallel reactors, each with a volume of 20,000 gallons. The plant's normal operating mode is to have both units available. One unit has sufficient capacity to process all average daily and typical peak hourly flows. During extreme sustained peak flow periods, both units normally operate. Since the efficiency of an aerated grit chamber is a function of the air flow rate fed into the reactor, the operator can adjust the grit removal rate by changing the air flow. Should one unit be down for repairs, a single unit can still treat all peak flow by increasing the amount of air into the aerator. The reactor also has a bypass channel that can be used to send flows around the grit reactors.

- Municipal flows are next sent to the bar rack and flow metering section of the headworks. The plant has two parallel influent channels and flow meters, each with a capacity of about 7.5 MGD. The flow meters consists of 12" wide Parshall flumes equipped with ultrasonic flow meters.

- The municipal flows are discharged from the municipal headworks and enter the primary flow splitter box where the operator can make flow allocation decisions between primary and secondary treatment and between the City's flows.

- The primary splitter box allows the operator to decide how much municipal flow will enter each of the plant's two 50' Ø primary clarifiers. The operator can also send some or all of the municipal flow directly to secondary treatment without the use of the primary clarifier. A series of adjustable weir gates is used to balance the flows between the primary and secondary treatment system. One of the primary clarifiers (PC#1) is dedicated solely to industrial flows from hauled wastewater. The other two clarifiers (PC #2 and #3) are available to treat peak flows from the City's municipal sewer system. During the 1998 peak flow upgrade of the plant, these clarifiers were sized to match the hydraulic capacity of the interceptor sewer. When peak flows to the plant occur, pump stations at Hardy Street, South Main Street and Brewer Cove fill the interceptor sewer to its capacity and send flows to the plant. The two municipal primary clarifiers have the capacity to process all of these flows and are, therefore, not adversely impacted by peak flows as long as they are both fully operational.

- Hauled wastewater flow which includes septic wastewater, landfill leachate, floor drain water, propolene glycol, etc. has exclusive use of

primary clarifier No. 1. Under normal conditions, primary clarifiers No. 2 and No. 3 are reserved for the City's flows.

- The primary splitter box also has provisions to allow portions of the municipal influent flow to be sent directly to secondary treatment without the use of primary treatment. During low flow periods, this feature allows the plant to maximize the organic load that is fed to the secondary treatment microbes. This helps to optimize the process efficiency of the plant's biological treatment system. If the facility is operating in a low flow period, one or both of the two municipal primary clarifiers may be empty. Should peak flows occur, these units are brought on-line as the flows begin to increase. This allows an initial capture and storage period to occur up to the 320,000 gallon capacity of the two primary reactors. Once flows pass this storage volume, the system achieves a steady state equilibrium and all peak flows receive primary treatment on a continuous basis.

- The municipal and industrial flows that enter the two 50' Ø primary clarifiers are allowed to pass through these reactors under quiescent conditions that allow several hours of detention time. Settleable solids in the raw sewage settles to the bottom of the clarifiers and is removed by sludge pumps.

- Four primary sludge pumps serve the plant's three primary clarifiers. One pump is generally on-line for each reactor with the fourth on-line for each reactor with the fourth pump available as a spare. A series of valves and header pipes allows the pump suction and discharge locations to be modified between clarifiers.

- Primary sludge and septic sludge is typically pumped into two 20' Ø gravity thickener units where the sludge is resettled and thickened. The thickener can be bypassed if necessary and primary sludge from the clarifiers can be sent directly to the plant's sludge dewatering presses if necessary.

- At the discharge end of the primary clarifiers, the municipal primary effluent enters the secondary flow splitter box. In this reactor, a series of weir gates are used to divide the municipal flow between the downstream secondary system and the peak flow bypass of secondary. As part of the plant's 1998 peak flow upgrade, the system was designed to accept sustained and peak flows into the secondary treatment system up to its hydraulic capacity. When this point is reached, all further

municipal primary flows are conveyed around secondary treatment to prevent it from being washed out and overloaded.

- A selector basin is located at the inlet of the plant's secondary treatment system. The selector consists of two 50,000 gallon reactors that can be operated either in series, parallel or completely bypassed. The selector provides a brief, mixed contact volume where microbes in the return sludge flow from the final clarifiers can mix with organic pollutants contained in the primary effluent from the secondary flow splitter box.

- Two complete-mix 450,000 gallon parallel aeration basins follow the selector. Two 75 HP surface aerators provide oxygen to each aeration basin and keep their contents mixed. In the aeration basins, contact time is provided for microbes to grow and biodegrade the organic content of the sewage pollutants.

- Two splitter boxes are located at the end of the aeration basins. These boxes contain weir gates that allow the operator to decide how to allocate flows between the four final clarifiers.

- Four final clarifier reactors are used to separate microbes from the aeration basin's discharge from the clean water that contains these microbes. If the biological treatment process in the aeration basins is optimized, the majority of the biodegradable organic pollutant content that was originally contained in the influent to the aeration basins will be now contained within the microbial cell mass by the time that the incoming wastewater reaches the end of the reactor. If this water is discharged into final clarifiers, and if the microbial cells can be settled in the clarifiers, clean water will be created in a decant zone over the settling sludge blanket. Brewer's plant utilizes two 65' Ø and two 55' Ø final clarifiers to allow aeration basin microbes to be settled from the flow stream. The decanted supernatant left over the settling microbes is generally clean enough to be discharged to the Penobscot River after first being disinfected.

- A series of return sludge pumps is used to recirculate settled sludge from the clarifiers back to the selector basin or aeration basins. This allows the microbes grown in the aeration basins to be returned to the reactor for further treatment of new wastes. Each return sludge line has a magnetic flow meter to allow the return sludge flow rate to be measured and recorded. A series of valves in the pump room allows flexibility in allocating various combinations of return sludge pumps to different clarifiers.

- Effluent from the final clarifiers is sent to the 200,000 gallon chlorine contact tank for disinfection. During peak wet weather events, flows from the final clarifiers are combined with bypassed flows from the secondary splitter box. The chlorine contact tank is used to process the entire peak flows that the plant receives. Flows reach the contact tank through two separate 18" flumes, one for normal secondary treatment flows from the final clarifiers and one for the bypassed primary effluent flow from the secondary splitter box. Each flume has its own ultrasonic flow meter and chemical feed system that flow paces the chlorine in proportion to the flow rate. There are redundant chemical feed pumps for each flow stream.

- Flow from the chlorine contact tank is discharged as treated effluent to the Penobscot River through a 30" Ø ductile iron outfall pipe.

The above discussion summarizes the unit processes at the Brewer facility that transform raw sewage into clean, treated final effluent. These processes deal with the water treatment side of the plant. The facility also has a parallel, concurrent set of unit processes that address the solids management needs of the plant. As water is treated through each of the plant's unit processes, the removed pollutants collectively form sludges which must be processed and then disposed of by composting or landfilling. The Brewer facility has several unit processes in place to handle the plant's sludge streams to alter their character, and to modify their water content in an effort to reduce the final sludge volume requiring disposal. These processes include the following:

- As previously discussed, raw sludge removed the City's two primary clarifiers are pumped to two gravity thickeners for further settling, thickening, and concentration of the sludge blanket. These sludges are stored in the thickeners until the belt filter presses are ready for operation. Supernatant from the thickeners is sent back to the headworks of the plant for further treatment.

- Over time, growth of the aeration basin microbes will proceed until the population of microbes exceeds the level needed for proper wastewater treatment. In order to keep the biological processes in equilibrium, the operators must waste microbes from the plant. Three waste sludge pumps are connected to the return sludge pumping header. When these pumps are operated, a portion of the microbial sludges settled in the final clarifiers can be wasted from the system.

- Wasted biological sludges are first thickened on a dissolved air flotation (DAF) thickener. Polymer is added to the sludge to help flocculate and coagulate the solids. Pressurized air is added to the system at high pressure conditions. When this stream is released in the DAF unit, the rapid change in pressure causes air bubbles to come out of solution. These bubbles float the solids to the surface of the reactor where they are scraped off by a series of traveling rakes. The thickened sludge, or float, is then transferred by gravity to two 23,000 gallon aerated sludge holding tanks where the sludge is stored until the sludge press is ready for operation.

- The Brewer facility uses a series of six plunger pumps to convey thickened primary and secondary sludge to the plant's two belt filter presses. Three pumps process sludge streams from the two gravity thickeners and three sludge pumps convey thickened secondary waste sludge from the two aerated sludge storage tanks. A series of valves allows these pumps to be interchanged between respective reactors in the event that one of the primary or secondary thickened sludge pumps is down for repairs.

- The plant has two 2.0 meter, stainless steel belt filter presses in use to further dewater the waste primary and secondary sludges. Each press has redundant process equipment. The primary thickened sludge from the gravity thickeners and the secondary thickened sludge from the storage tanks are blended into a single pipe that feeds each press. The combined sludge streams flow through a grinder to shred debris and through a blend tank to further unify the primary and secondary sludge streams. Polymer is added to the sludge and sludge is measured with a magnetic flow meter prior to entering the press. Each sludge press has a gravity drainage zone where flocculated sludge is placed on a cloth belt. As the belt travels into the press, free water between the flocculated sludge particles drains from the sludge and is returned to the plant's headworks for further treatment. The remaining sludge solids are then squeezed between two moving fabric belts that are passed between rollers of increasing pressure. This causes additional water to be squeezed out from the sludge. As the sludge is removed from the press at the end of the roller section, a washwater pump is used to clean the belts.

- Dewatered sludge is scraped from the belts using a doctor blade and falls into a screw conveyor. The dewatered sludge is then discharged into a 30 yard roll-off container for its transport to the compost site. At present, the City contracts with a private sludge management company

(Hawk Ridge Compost facility owned by Casella) to compost or landfill its sludge.

Table 2 below summarizes the unit processes that are presently in place at the Brewer Water Pollution Control Facility for the treatment of both the plant's wastewater and sludge streams.

TABLE 2: SUMMARY OF UNIT TREATMENT PROCESSES

UNIT PROCESS	DESIGN PARAMETER	DESCRIPTION
Grit Removal	Type	Aerated rectangular chambers
	Number	Two parallel units
	Size	20,000 gallons each
	Removal system	2 HP, 12" Ø screw conveyors
	Aeration system	Three 10 HP blowers w/VFD
	Blower capacity	300 ACFM @ 5 psi
	Grit pumps	Two Wemco slurry pumps
	Pump rating	10 HP, 460 VAC, 1800 RPM
	Pump capacity	300 GPM @ 33'TDH
	Grit classifiers	Two 10" Ø vortex
	Grit washers	Two 12" Ø inclined screws
	Conveyor	1 HP, 24" wide belt conveyor
Septic Receiving Station	To be installed in 2010	June to October
Municipal flow meters	Type	Parshall flumes with ultrasonic meters
	Flume size	12" throat width
	Meter model	Fisher-Porter 50PL2610A33
	Number	Two parallel units
Whitewater flow meter	Type	Parshall flume with ultrasonic meter
	Flume size	6" throat width
	Meter model	Fisher-Porter 50US141BBB
	Number	One unit
Whitewater lift pumps	Wet well volume	10,000 gallons
	Pump type	Three Paco vertical turbine with VFD
	Model	612 NCF

	Rating	20 HP, 460 VAC, 1750 RPM Max.
	Capacity	1000 GPM @ 33’ TDH
Primary splitter box	Type	Constant head box
	Municipal control	Three weir gates
	Whitewater control	Two slide gates
Primary clarifiers	Number of units	Three circular units
	Volume	160,000 gallons each
	Diameter	50’ Ø each
	Surface area	1960 SF/each
	Depth	10’ deep at sidewall
	Sludge rakes	1 HP
Selector basin	Type	Mixed anoxic selector
	Number	Two parallel square units
	Size	50,000 gallons each
	Mixers	Two 3 HP, 460 VAC, 1200 RPM
	Models	Aqua-Aerobic Model SS-5900311
Aeration basins	Number of units	Two complete mix rectangular
	Capacity	450,000 gallons each
	Dimensions	45’ wide x 95’ long each
	Depth	15’ deep
	Aerators	Four surface mechanical mixers
	Size	75 HP, 460 VAC, 1800 RPM
	Model	EIMCO LS X 75 HP
Final clarifiers	Number of units	Four circular units
	Diameter	Two @ 55’ Ø/ Two @ 65’ Ø
	Volume	Two @ 215,000 gal/ea/Two @ 300,000 gal/ea
	Depth	12’ deep at sidewall
	Area	Two @ 2375 SF/Two @ 3320 SF
	Sludge rakes	0.50 HP
Chlorine contact tank	Type	Rectangular plug flow
	Number	Two parallel units
	Volume	100,000 gallons/each
	Length/width ratio	70 to 1
	Secondary chlorination pumps	2.1 GPH @ 20 psi (Masterflex Model 955-1010)
	Bypass chlorination pumps	2.1 GPH @ 20 psi (Same as secondary)
Raw primary sludge pumps	Number of pumps	Four Paco centrifugal pumps w/VFD
	Model	Paco 78-49531-346C35NCH

	Rating	5 HP, 460 VAC, 875 RPM
	Capacity	325 GPM @ 22' TDH
	Flow meters	Two units @ 400 GPM each
	Model	Fischer-Porter 10D1475PN15PL29KY12A1112C1
Gravity sludge thickeners	Number of units	Two circular units
	Diameter	20' Ø each
	Surface area	320 SF each
	Volume	25,000 gallons each
Thickened primary sludge pumps	Number of pumps	Three Komline piston plunger pumps with VFD
	Model	KS-9-2
	Rating	7.5 HP, 460 VAC, 1740 RPM
	Capacity	180 GPM @ 80" TDH
Return activated sludge pumps	Number of pumps	Five Paco centrifugal w/VFD
	Model	52-61214-358C10NCH
	Rating	7.5 HP, 460 VAC, 875 RPM
	Capacity	800 GPM @ 15' TDH
	Flow meters	Four 6" Ø magnetic
	Meter capacity	0 to 1200 GPM
	Model	Fisher-Porter
Waste activated sludge pumps	Number of pumps	Three Paco centrifugal w/VFD
	Model	52-49512-346CONCH
	Rating	3 HP, 460 VAC, 1170 RPM
	Capacity	300 GPM @ 16" TDH'
	Flow meters	Two 4" Ø magnetic
	Meter capacity	0 to 400 GPM
	Model	Fisher-Porter
Waste sludge thickener	Type	Dissolved air flotation
	Model	Envirex Float-treat Thickener
	Surface Area	10' wide x 25' long
	Recycle pumps	15 HP, 460 VAC, 3,500 RPM
	Sludge storage	Two 23,000 gallon tanks
Thickened waste sludge pumps	Number of pumps	Three Komline plunger pumps w/VFD
	Model	KS-9-2
	Rating	7.5 HP, 460 VAC, 1700 RPM
	Capacity	180 GPM @ 80' TDH'
Sludge dewatering system	Type	Two 2.0m belt filter presses
	Model	KS-Model GRS-SE-2-55
	Rating	3 HP, 460VAC, 1760 RPM
	Capacity	120 GPM/1800 lbs./hour

Air compressor model	Quincy F206
Air rating	2.0 C.F.M.
Air dryer model	Harrison PR-5
Grinder model	Muffin Monster 30000-1206
Grinder rating	600 GPM
Flow meter model	Khrone IFC-080 MD
Flow meter size	4”
Blend tank size	200
Blend tank mixer	1/3 HP< 460 VAC, Lightin XJC-30
Polymer system model	Stranco Polyblend PB 1000-2
Polymer system size	1200 GPM Dilution, 8 GPM Pump
Washwater pump model	Ingersol Rand HC
Washwater pump size	60 GPM @ 70 TDH’